

JEE MAIN 2021 · QUESTION PAPER

25 Feb 2021 **Shift 2**

82 questions in exam order, with answer key

Subject	Section A multiple choice	Section B numerical value
● Physics	19 Q1 to Q19	10 Q20 to Q29
● Chemistry	16 Q30 to Q45	9 Q46 to Q54
● Mathematics	19 Q55 to Q73	9 Q74 to Q82
In this PDF	82 questions · answer key at the end	

- 1 Set a 3 hour timer and attempt the paper in one sitting, like the real exam.
- 2 In the 2021 to 2024 papers, Section B asked you to answer any 5 numerical questions per subject. Try each one here.
- 3 Check yourself against the answer key at the end. Every question names its chapter, so you can see where marks went.
- 4 Got one wrong? Tap “Step-by-step solution” at the top right of it for the full working, where available.

Attempt this paper online

The same questions in the same order, with instant answer checking and step-by-step solutions where available.

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Answers follow NTA's final answer keys. Typing errors are possible, so check doubtful answers against the official key. Spotted a mistake? prepwis.in/feedback · Terms: prepwis.in/terms

Q1 Alternating Current

[Step-by-step solution](#) · [prepwiser.in/questions/MZ9MQBSQur](https://www.prepwiser.in/questions/MZ9MQBSQur)

An LCR circuit contains resistance of 110Ω and a supply of 220 V at 300 rad/s angular frequency. If only capacitance is removed from the circuit, current lags behind the voltage by 45° . If on the other hand, only inductor is removed the current leads by 45° with the applied voltage. The rms current flowing in the circuit will be:

- (A) 1 A (B) 2.5 A (C) 2 A (D) 1.5 A

Q2 Semiconductors & Electronic Devices

[Step-by-step solution](#) · [prepwiser.in/questions/kC8j1YF4_2](https://www.prepwiser.in/questions/kC8j1YF4_2)

Match List I with List II.

	List I		List II
(a)	Rectifier	(i)	Used either for stepping up or stepping down the a.c. voltage
(b)	Stabilizer	(ii)	Used to convert a.c. voltage into d.c. voltage
(c)	Transformer	(iii)	Used to remove any ripple in the rectified output voltage
(d)	Filter	(iv)	Used for constant output voltage even when the input voltage or load current change

Choose the correct answer from the options given below:

- (A) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii) (B) (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)
 (C) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii) (D) (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)

Q3 Atomic Physics

[Step-by-step solution](#) · [prepwiser.in/questions/gf0YbsRsKK](https://www.prepwiser.in/questions/gf0YbsRsKK)

The wavelength of the photon emitted by a hydrogen atom when an electron makes a transition from $n = 2$ to $n = 1$ state is:

- (A) 194.8 nm (B) 490.7 nm (C) 913.3 nm (D) 121.8 nm

Q4 Electrostatics I: Charges, Field & Gauss's Law

[Step-by-step solution](#) · [prepwiser.in/questions/V5nbRrEcde](https://www.prepwiser.in/questions/V5nbRrEcde)

An electron with kinetic energy K_1 enters between parallel plates of a capacitor at an angle ' α ' with the plates. It leaves the plates at angle ' β ' with kinetic energy K_2 . Then the ratio of kinetic energies $K_1 : K_2$ will be:

- (A) $\frac{\cos^2 \beta}{\cos^2 \alpha}$ (B) $\frac{\cos \beta}{\cos \alpha}$ (C) $\frac{\sin^2 \beta}{\cos^2 \alpha}$ (D) $\frac{\cos \beta}{\sin \alpha}$

Q5 Dual Nature of Radiation & Matter

[Step-by-step solution](#) · [prepwiser.in/questions/UlTf2fvHNA](https://www.prepwiser.in/questions/UlTf2fvHNA)

An electron of mass m_e and a proton of mass $m_p = 1836 m_e$ are moving with the same speed. The ratio of their de Broglie wavelength $\frac{\lambda_{electron}}{\lambda_{proton}}$ will be:

- (A) 1 (B) 1836 (C) $\frac{1}{1836}$ (D) 918

Q6 Dual Nature of Radiation & Matter

[Step-by-step solution](#) · [prepwiser.in/questions/2RK4XsGeWC](https://www.prepwiser.in/questions/2RK4XsGeWC)

The stopping potential for electrons emitted from a photosensitive surface illuminated by light of wavelength 491 nm is 0.710 V. When the incident wavelength is changed to a new value, the stopping potential is 1.43 V. The new wavelength is:

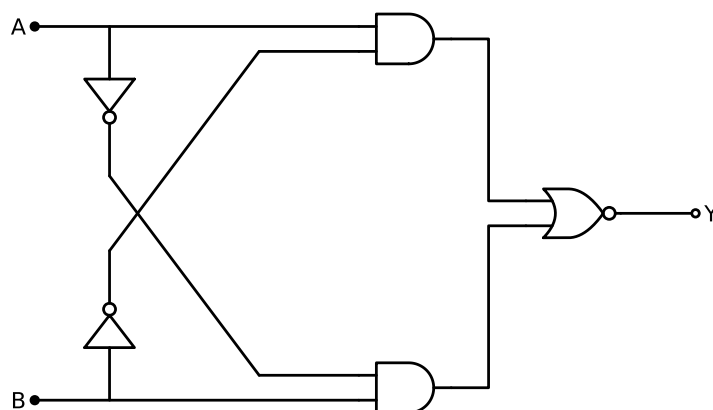
- (A) 400 nm (B) 329 nm (C) 309 nm (D) 382 nm

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For extrinsic semiconductors; when doping level is increased;

- (A) Fermi-level of both p-type and n-type semiconductors will go upward for $T > T_F K$ and downward for $T < T_F K$, where T_F is Fermi temperature.
- (B) Fermi-level of p-type semiconductor will go upward and Fermi-level of n-type semiconductors will go downward
- (C) Fermi-level of p and n-type semiconductors will not be affected.
- (D) Fermi-level of p-type semiconductors will go downward and Fermi-level of n-type semiconductor will go upward.

The truth table for the following logic circuit is:



(A)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(B)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

(C)

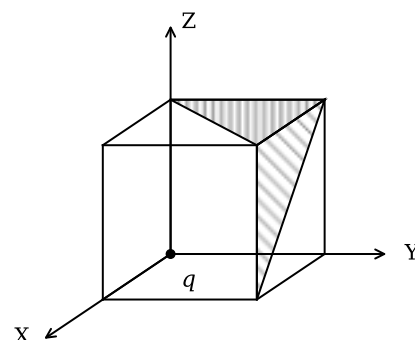
A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

(D)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

A charge 'q' is placed at one corner of a cube as shown in figure. The flux of electrostatic field $\vec{E}$ through the shaded area is:

- (A) $\frac{q}{24\epsilon_0}$ (B) $\frac{q}{48\epsilon_0}$ (C) $\frac{q}{4\epsilon_0}$ (D) $\frac{q}{8\epsilon_0}$



Given below are two statements:

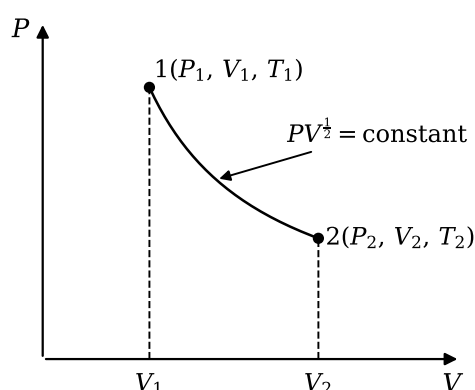
Statement I : In a diatomic molecule, the rotational energy at a given temperature obeys Maxwell's distribution.

Statement II : In a diatomic molecule, the rotational energy at a given temperature equals the translational kinetic energy for each molecule.

In the light of the above statements, choose the correct answer from the options given below:

- (A) Both Statement I and Statement II are true (B) Both Statement I and Statement II are false
(C) Statement I is true but Statement II is false. (D) Statement I is false but Statement II is true.

Thermodynamic process is shown below on a P-V diagram for one mole of an ideal gas. If $V_2 = 2V_1$ then the ratio of temperature T_2/T_1 is:



- (A) $\sqrt{2}$ (B) $\frac{1}{\sqrt{2}}$ (C) $\frac{1}{2}$ (D) 2

In a ferromagnetic material, below the curie temperature, a domain is defined as:

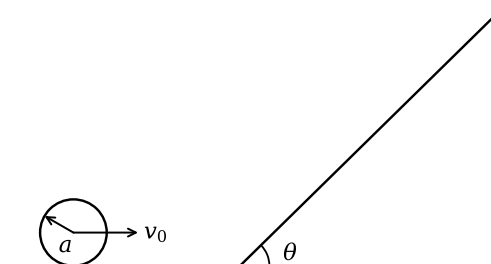
- (A) a macroscopic region with zero magnetization.
(B) a macroscopic region with saturation magnetization.
(C) a macroscopic region with randomly oriented magnetic dipoles.
(D) a macroscopic region with consecutive magnetic dipoles oriented in opposite direction.

A stone is dropped from the top of a building. When it crosses a point 5 m below the top, another stone starts to fall from a point 25 m below the top. Both stones reach the bottom of building simultaneously. The height of the building is:

- (A) 50 m (B) 25 m (C) 45 m (D) 35 m

A sphere of radius 'a' and mass 'm' rolls along a horizontal plane with constant speed v_0 . It encounters an inclined plane at angle θ and climbs upward. Assuming that it rolls without slipping, how far up the sphere will travel?

- (A) $\frac{v_0^2}{2g \sin \theta}$ (B) $\frac{7v_0^2}{10g \sin \theta}$ (C) $\frac{2}{5} \frac{v_0^2}{g \sin \theta}$ (D) $\frac{v_0^2}{5g \sin \theta}$



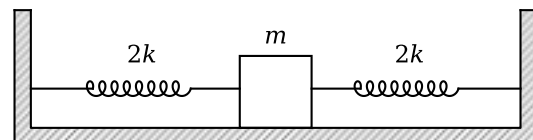
Q15 Simple Harmonic Motion[Step-by-step solution](https://www.prepwise.in/questions/uBn8RbmIIQ)

$Y = A \sin(\omega t + \phi_0)$ is the time-displacement equation of a SHM. At $t = 0$ the displacement of the particle is $Y = \frac{A}{2}$ and it is moving along negative x-direction. Then the initial phase angle ϕ_0 will be:

- (A) $\frac{5\pi}{6}$ (B) $\frac{\pi}{3}$ (C) $\frac{2\pi}{3}$ (D) $\frac{\pi}{6}$

Q16 Simple Harmonic Motion[Step-by-step solution](https://www.prepwise.in/questions/xvIE1-23G8)

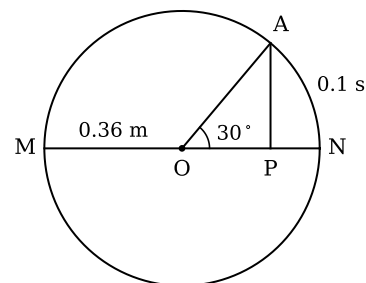
Two identical springs of spring constant ' $2k$ ' are attached to a block of mass m and to fixed support (see figure). When the mass is displaced from equilibrium position on either side, it executes simple harmonic motion. The time period of oscillations of this system is:



- (A) $2\pi\sqrt{\frac{m}{k}}$ (B) $\pi\sqrt{\frac{m}{k}}$ (C) $2\pi\sqrt{\frac{m}{2k}}$ (D) $\pi\sqrt{\frac{m}{2k}}$

Q17 Simple Harmonic Motion[Step-by-step solution](https://www.prepwise.in/questions/VZOoWexAGK)

The point A moves with a uniform speed along the circumference of a circle of radius 0.36 m and covers 30° in 0.1 s. The perpendicular projection 'P' from 'A' on the diameter MN represents the simple harmonic motion of 'P'. The restoration force per unit mass when P touches M will be:



- (A) 9.87 N (B) 0.49 N (C) 50 N (D) 100 N

Q18 Wave Optics[Step-by-step solution](https://www.prepwise.in/questions/ckT0V8rMil)

Consider the diffraction pattern obtained from the sunlight incident on a pinhole of diameter $0.1 \mu\text{m}$. If the diameter of the pinhole is slightly increased, it will affect the diffraction pattern such that:

- (A) its size increases, but intensity decreases (B) its size increases, and intensity increases
(C) its size decreases, but intensity increases (D) its sizes decreases, and intensity decreases

Q19 Units, Dimensions & Errors[Step-by-step solution](https://www.prepwise.in/questions/bdnG-tmU99)

If e is the electronic charge, c is the speed of light in free space and h is Planck's constant, the quantity $\frac{1}{4\pi\epsilon_0} \frac{|e|^2}{hc}$ has dimensions of:

- (A) $[MLT^{-1}]$ (B) $[MLT^0]$ (C) $[M^0L^0T^0]$ (D) $[LC^{-1}]$

Physics Section B · Numerical value

Q20 to Q29

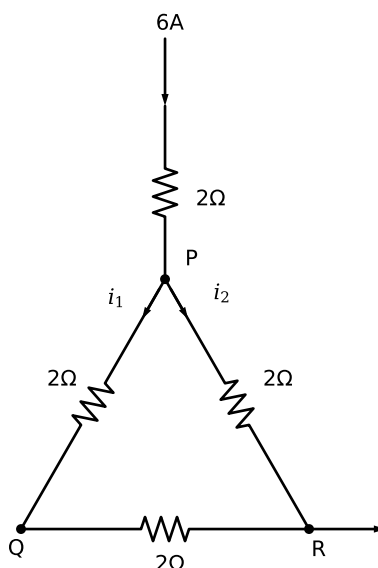
Q20 Centre of Mass & Linear Momentum **NUMERICAL**[Step-by-step solution](https://www.prepwise.in/questions/DjeIQUVKvR)

Two particles having masses 4 g and 16 g respectively are moving with equal kinetic energies. The ratio of the magnitudes of their linear momentum is $n : 2$. The value of n will be _____.

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Q21 Current Electricity **NUMERICAL**[Step-by-step solution](https://prepwiser.in/questions/gBF5LnFAZw)

A current of 6A enters one corner P of an equilateral triangle PQR having 3 wires of resistance 2Ω each and leaves by the corner R. The currents i_1 in ampere is _____.

**Q22** Electromagnetic Waves **NUMERICAL**[Step-by-step solution](https://prepwiser.in/questions/u4uEF03C xv)

The peak electric field produced by the radiation coming from the 8W bulb at a distance of 10 m is $\frac{x}{10} \sqrt{\frac{\mu_0 c}{\pi}} \frac{V}{m}$. The bulb is a point source. The value of x is _____.

Q23 Dual Nature of Radiation & Matter **NUMERICAL**[Step-by-step solution](https://prepwiser.in/questions/w8SJesen4y)

The wavelength of an X-ray beam is $10^{\circ} \text{\AA}$. The mass of a fictitious particle having the same energy as that of the X-ray photons is $\frac{x}{3} h$ kg. The value of x is _____. (h = Planck's constant)

Q24 Electrostatics I: Charges, Field & Gauss's Law **NUMERICAL**[Step-by-step solution](https://prepwiser.in/questions/QK2JAmQ_eG)

Two identical conducting spheres with negligible volume have 2.1 nC and -0.1 nC charges, respectively. They are brought into contact and then separated by a distance of 0.5 m. The electrostatic force acting between the spheres is _____ $\times 10^{-9}$ N.
[Given: $4\pi\epsilon_0 = \frac{1}{9 \times 10^9}$ SI unit]

Q25 Electrostatics I: Charges, Field & Gauss's Law **NUMERICAL**[Step-by-step solution](https://prepwiser.in/questions/OBQNSowpce)

Two small spheres each of mass 10 mg are suspended from a point by threads 0.5 m long. They are equally charged and repel each other to a distance of 0.20 m. The charge on each of the sphere is $\frac{a}{21} \times 10^{-8} \text{C}$. The value of 'a' will be _____. [Given $g = 10 \text{ ms}^{-2}$]

Q26 Gravitation **NUMERICAL**[Step-by-step solution](https://prepwiser.in/questions/ntbKJydhLN)

The initial velocity v_i required to project a body vertically upward from the surface of the earth to reach a height of $10R$, where R is the radius of the earth, may be described in terms of escape velocity v_e such that $v_i = \sqrt{\frac{x}{y}} \times v_e$. The value of x will be _____.

Q27 Thermodynamics **NUMERICAL**[Step-by-step solution](https://prepwiser.in/questions/71WCHHA3iE)

A reversible heat engine converts one-fourth of the heat input into work. When the temperature of the sink is reduced by 52K, its efficiency is doubled. The temperature in Kelvin of the source will be _____.

The percentage increase in the speed of transverse waves produced in a stretched string if the tension is increased by 4%, will be _____%.

If $\vec{P} \times \vec{Q} = \vec{Q} \times \vec{P}$, the angle between $\vec{P}$ and $\vec{Q}$ is θ ($0^\circ < \theta < 360^\circ$). The value of ' θ ' will be _____°.

Chemistry Section A · Multiple choice

Q30 to Q45

Which of the following is correct structure of α -anomer of maltose?

- (A)
- (B)
- (C)
- (D)

Which among the following species has unequal bond lengths?

(A) XeF_4 (B) BF_4^- (C) SiF_4 (D) SF_4

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In which of the following order the given complex ions are arranged correctly with respect to their decreasing spin only magnetic moment?

- (i) $[\text{FeF}_6]^{3-}$
- (ii) $[\text{Co}(\text{NH}_3)_6]^{3+}$
- (iii) $[\text{NiCl}_4]^{2-}$
- (iv) $[\text{Cu}(\text{NH}_3)_4]^{2+}$

(A) (iii) > (iv) > (ii) > (i) (B) (ii) > (iii) > (i) > (iv) (C) (i) > (iii) > (iv) > (ii) (D) (ii) > (i) > (iii) > (iv)

The correct sequence of reagents used in the preparation of 4-bromo-2-nitroethyl benzene from benzene is:

- (A) $\text{CH}_3\text{COCl} / \text{AlCl}_3, \text{Br}_2 / \text{AlBr}_3, \text{HNO}_3 / \text{H}_2\text{SO}_4, \text{Zn} / \text{HCl}$
- (B) $\text{CH}_3\text{COCl} / \text{AlCl}_3, \text{Zn} - \text{Hg} / \text{HCl}, \text{Br}_2 / \text{AlBr}_3, \text{HNO}_3 / \text{H}_2\text{SO}_4$
- (C) $\text{Br}_2 / \text{AlBr}_3, \text{CH}_3\text{COCl} / \text{AlCl}_3, \text{HNO}_3 / \text{H}_2\text{SO}_4, \text{Zn} / \text{HCl}$
- (D) $\text{HNO}_3 / \text{H}_2\text{SO}_4, \text{Br}_2 / \text{AlCl}_3, \text{CH}_3\text{COCl} / \text{AlCl}_3, \text{Zn} - \text{Hg} / \text{HCl}$

Water does not produce CO on reacting with:

- (A) C (B) CH_4 (C) C_3H_8 (D) CO_2

The solubility of $\text{Ca}(\text{OH})_2$ in water is:

[Given : The solubility product of $\text{Ca}(\text{OH})_2$ in water = 5.5×10^{-6}]

- (A) 1.11×10^{-6} (B) 1.11×10^{-2} (C) 1.77×10^{-6} (D) 1.77×10^{-2}

The major components of German Silver are:

- (A) Zn, Ni and Ag (B) Cu, Zn and Ni (C) Cu, Zn and Ag (D) Ge, Cu and Ag

The method used for the purification of Indium is:

- (A) zone refining (B) vapour phase refining
(C) liquation (D) van Arkel method

Given below are two statements:

Statement I: α and β forms of sulphur can change reversibly between themselves with slow heating or slow cooling.

Statement II : At room temperature the stable crystalline form of sulphur is monoclinic sulphur.

In the light of the above statements, choose the correct answer from the options given below:

- (A) Statement I is true but Statement II is false. (B) Statement I is false but Statement II is true.
(C) Both Statement I and Statement II are true. (D) Both Statement I and Statement II are false.

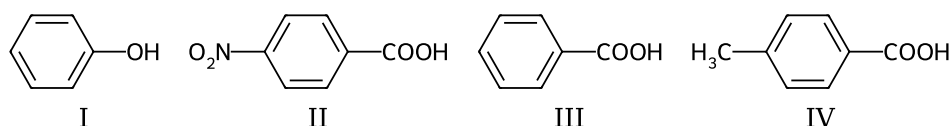
The correct order of bond dissociation enthalpy of halogens is:

- (A) $F_2 > Cl_2 > Br_2 > I_2$ (B) $Cl_2 > Br_2 > F_2 > I_2$ (C) $I_2 > Br_2 > Cl_2 > F_2$ (D) $Cl_2 > F_2 > Br_2 > I_2$

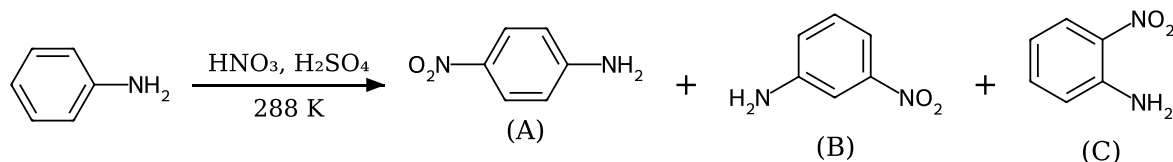
Which one of the following statements is FALSE for hydrophilic sols?

- (A) They do not require electrolytes for stability. (B) The sols cannot be easily coagulated.
(C) These sols are reversible in nature. (D) Their viscosity is of the order of that of H_2O .

The correct order of acid character of the following compounds is:



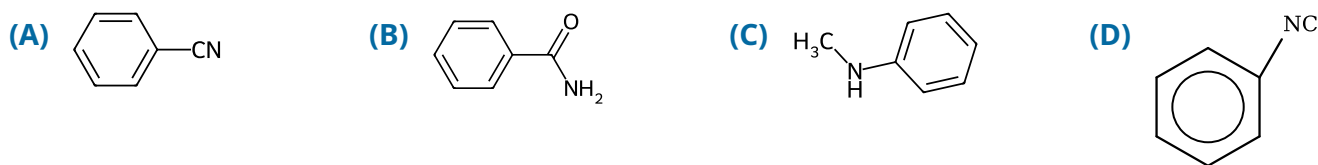
- (A) $IV > III > II > I$ (B) $III > II > I > IV$ (C) $II > III > IV > I$ (D) $I > II > III > IV$



Correct statement about the given chemical reaction is:

- (A) $-NH_2$ group is *ortho* and *para* directive, so product (B) is not possible.
(B) Reaction is possible and compound (B) will be the major product.
(C) Reaction is possible and compound (A) will be major product.
(D) The reaction will form sulphonated product instead of nitration.

Carbylamine test is used to detect the presence of primary amino group in an organic compound. Which of the following compound is formed when this test is performed with aniline?



Which of the following compound is added to the sodium extract before addition of silver nitrate for testing of halogens?

- (A) Nitric acid (B) Sodium hydroxide (C) Ammonia (D) Hydrochloric acid

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Given below are two statements:

Statement I : The identification of Ni^{2+} is carried out by dimethyl glyoxime in the presence of NH_4OH .

Statement II : The dimethyl glyoxime is a bidentate neutral ligand.

In the light of the above statements, choose the correct answer from the options given below:

- (A) Statement I is false but Statement II is true. (B) Statement I is true but Statement II is false.
(C) Both Statement I and Statement II are false. (D) Both Statement I and Statement II are true.

Chemistry Section B · Numerical value

Q46 to Q54

The number of compound/s given below which contain/s $-\text{COOH}$ group is _____. (Integer answer)

- (A) Sulphanilic acid
(B) Picric acid
(C) Aspirin
(D) Ascorbic acid

The rate constant of a reaction increases by five times on increase in temperature from 27°C to 52°C .

The value of activation energy in kJ mol^{-1} is _____. (Rounded off to the nearest integer)

[$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$]

Copper reduces NO_3^- into NO and NO_2 depending upon the concentration of HNO_3 in solution.

(Assuming fixed $[\text{Cu}^{2+}]$ and $P_{\text{NO}} = P_{\text{NO}_2}$), the HNO_3 concentration at which the thermodynamic tendency for reduction of NO_3^- into NO and NO_2 by copper is same is 10^x M . The value of $2x$ is _____. (Rounded off to the nearest integer)

[Given, $E_{\text{Cu}^{2+}/\text{Cu}}^o = 0.34 \text{ V}$, $E_{\text{NO}_3^-/\text{NO}}^o = 0.96 \text{ V}$, $E_{\text{NO}_3^-/\text{NO}_2}^o = 0.79 \text{ V}$ and at 298 K , $\frac{RT}{F}(2.303) = 0.059$]

The unit cell of copper corresponds to a face centered cube of edge length $3.596 \text{ \AA}$ with one copper atom at each lattice point. The calculated density of copper in kg/m^3 is _____. [Molar mass of Cu : 63.54 g ; Avogadro Number = 6.022×10^{23}]

If a compound AB dissociates to the extent of 75% in an aqueous solution, the molality of the solution which shows a 2.5 K rise in the boiling point of the solution is _____ molal. (Rounded off to the nearest integer)

[$K_b = 0.52 \text{ K kg mol}^{-1}$]

Electromagnetic radiation of wavelength 663 nm is just sufficient to ionise the atom of metal A. The ionization energy of metal A in kJ mol^{-1} is _____. (Rounded off to the nearest integer)

[$h = 6.63 \times 10^{-34} \text{ Js}$, $c = 3.00 \times 10^8 \text{ ms}^{-1}$, $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$]

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Among the following, number of metal/s which can be used as electrodes in the photoelectric cell is _____. (Integer answer)

- (A) Li
- (B) Na
- (C) Rb
- (D) Cs

Five moles of an ideal gas at 293 K is expanded isothermally from an initial pressure of 2.1 MPa to 1.3 MPa against at constant external pressure 4.3 MPa. The heat transferred in this process is _____ kJ mol⁻¹. (Rounded off to the nearest integer) [Use R = 8.314 J mol⁻¹K⁻¹]

Consider titration of NaOH solution versus 1.25 M oxalic acid solution. At the end point following burette readings were obtained.

- (i) 4.5 mL
- (ii) 4.5 mL
- (iii) 4.4 mL
- (iv) 4.4 mL
- (v) 4.4 mL

If the volume of oxalic acid taken was 10.0 mL then the molarity of the NaOH solution is _____ M. (Rounded off to the nearest integer)

Mathematics Section A · Multiple choice

Q55 to Q73

A plane passes through the points A(1, 2, 3), B(2, 3, 1) and C(2, 4, 2). If O is the origin and P is (2, -1, 1), then the projection of $\overrightarrow{OP}$ on this plane is of length:

- (A) $\sqrt{\frac{2}{7}}$
- (B) $\sqrt{\frac{2}{5}}$
- (C) $\sqrt{\frac{2}{3}}$
- (D) $\sqrt{\frac{2}{11}}$

If $\alpha, \beta \in \mathbb{R}$ are such that $1 - 2i$ (here $i^2 = -1$) is a root of $z^2 + \alpha z + \beta = 0$, then $(\alpha - \beta)$ is equal to:

- (A) -7
- (B) 7
- (C) 3
- (D) -3

If $I_n = \int_{\frac{\pi}{4}}^{\frac{\pi}{2}} \cot^n x \, dx$, then:

- (A) $\frac{1}{I_2+I_4}, \frac{1}{I_3+I_5}, \frac{1}{I_4+I_6}$ are in A.P.
- (B) $I_2 + I_4, I_3 + I_5, I_4 + I_6$ are in A.P.
- (C) $\frac{1}{I_2+I_4}, \frac{1}{I_3+I_5}, \frac{1}{I_4+I_6}$ are in G.P.
- (D) $I_2 + I_4, (I_3 + I_5)^2, I_4 + I_6$ are in G.P.

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Q58 Limits[Step-by-step solution](#) > [prepwiser.in/questions/RCpwufqIqo](https://www.prepwiser.in/questions/RCpwufqIqo)

$$\lim_{n \rightarrow \infty} \left[\frac{1}{n} + \frac{n}{(n+1)^2} + \frac{n}{(n+2)^2} + \dots + \frac{n}{(2n+1)^2} \right]$$

is equal to:

- (A) $\frac{1}{2}$ (B) $\frac{1}{3}$ (C) 1 (D) $\frac{1}{4}$

Q59 Ellipse[Step-by-step solution](#) > [prepwiser.in/questions/uzphOMkbwl](https://www.prepwiser.in/questions/uzphOMkbwl)

If the curve $x^2 + 2y^2 = 2$ intersects the line $x + y = 1$ at two points P and Q, then the angle subtended by the line segment PQ at the origin is:

- (A) $\frac{\pi}{2} - \tan^{-1}\left(\frac{1}{4}\right)$ (B) $\frac{\pi}{2} + \tan^{-1}\left(\frac{1}{3}\right)$ (C) $\frac{\pi}{2} - \tan^{-1}\left(\frac{1}{3}\right)$ (D) $\frac{\pi}{2} + \tan^{-1}\left(\frac{1}{4}\right)$

Q60 Functions (Advanced)[Step-by-step solution](#) > [prepwiser.in/questions/Kcvxdq079A](https://www.prepwiser.in/questions/Kcvxdq079A)

A function $f(x)$ is given by $f(x) = \frac{5^x}{5^x + 5}$, then the sum of the series

$$f\left(\frac{1}{20}\right) + f\left(\frac{2}{20}\right) + f\left(\frac{3}{20}\right) + \dots + f\left(\frac{39}{20}\right)$$

is equal to:

- (A) $\frac{39}{2}$ (B) $\frac{19}{2}$ (C) $\frac{49}{2}$ (D) $\frac{29}{2}$

Q61 Relations & Functions (Basic)[Step-by-step solution](#) > [prepwiser.in/questions/pwfp-DQ1z](https://www.prepwiser.in/questions/pwfp-DQ1z)

Let x denote the total number of one-one functions from a set A with 3 elements to a set B with 5 elements and y denote the total number of one-one functions from the set A to the set $A \times B$. Then:

- (A) $2y = 273x$ (B) $y = 91x$ (C) $2y = 91x$ (D) $y = 273x$

Q62 Hyperbola[Step-by-step solution](#) > [prepwiser.in/questions/IIX_z0eCLx](https://www.prepwiser.in/questions/IIX_z0eCLx)

A hyperbola passes through the foci of the ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$ and its transverse and conjugate axes coincide with major and minor axes of the ellipse, respectively. If the product of their eccentricities is one, then the equation of the hyperbola is:

- (A) $\frac{x^2}{9} - \frac{y^2}{4} = 1$ (B) $\frac{x^2}{9} - \frac{y^2}{16} = 1$ (C) $\frac{x^2}{9} - \frac{y^2}{25} = 1$ (D) $x^2 - y^2 = 9$

Q63 Inverse Trigonometric Functions[Step-by-step solution](#) > [prepwiser.in/questions/jUGT9_RSH9](https://www.prepwiser.in/questions/jUGT9_RSH9)

cosec

$$\left[2\cot^{-1}(5) + \cos^{-1}\left(\frac{4}{5}\right) \right]$$

is equal to:

- (A) $\frac{75}{56}$ (B) $\frac{65}{56}$ (C) $\frac{56}{33}$ (D) $\frac{65}{33}$

Q64 Determinants[Step-by-step solution](#) > [prepwiser.in/questions/Hfg4ZX3ZKJ](https://www.prepwiser.in/questions/Hfg4ZX3ZKJ)

Let A be a 3×3 matrix with $\det(A) = 4$. Let R_i denote the i^{th} row of A. If a matrix B is obtained by performing the operation $R_2 \rightarrow 2R_2 + 5R_3$ on 2A, then $\det(B)$ is equal to:

- (A) 64 (B) 16 (C) 128 (D) 80

Q65 Matrices[Step-by-step solution](#) › [prepwisar.in/questions/NhR7WuTs2T](https://www.prepwisar.in/questions/NhR7WuTs2T)

If for the matrix,

$$A = \begin{bmatrix} 1 & -\alpha \\ \alpha & \beta \end{bmatrix}$$

, $AA^T = I_2$, then the value of $\alpha^4 + \beta^4$ is:

- (A) 3 (B) 2 (C) 1 (D) 4

Q66 Determinants[Step-by-step solution](#) › [prepwisar.in/questions/UVTVkcL_ki](https://www.prepwisar.in/questions/UVTVkcL_ki)

The following system of linear equations

$$2x + 3y + 2z = 9$$

$$3x + 2y + 2z = 9$$

$$x - y + 4z = 8$$

- (A) does not have any solution
(B) has a solution (α, β, γ) satisfying $\alpha + \beta^2 + \gamma^3 = 12$
(C) has a unique solution
(D) has infinitely many solutions

Q67 Parabola[Step-by-step solution](#) › [prepwisar.in/questions/2DkzReiDbc](https://www.prepwisar.in/questions/2DkzReiDbc)

The shortest distance between the line $x - y = 1$ and the curve $x^2 = 2y$ is:

- (A) 0 (B) $\frac{1}{2\sqrt{2}}$ (C) $\frac{1}{\sqrt{2}}$ (D) $\frac{1}{2}$

Q68 Probability: Basic[Step-by-step solution](#) › [prepwisar.in/questions/c0RK9iK-CY](https://www.prepwisar.in/questions/c0RK9iK-CY)

Let A be a set of all 4-digit natural numbers whose exactly one digit is 7. Then the probability that a randomly chosen element of A leaves remainder 2 when divided by 5 is:

- (A) $\frac{2}{9}$ (B) $\frac{1}{5}$ (C) $\frac{122}{297}$ (D) $\frac{97}{297}$

Q69 Probability: Advanced[Step-by-step solution](#) › [prepwisar.in/questions/SsSaGci0xy](https://www.prepwisar.in/questions/SsSaGci0xy)

In a group of 400 people, 160 are smokers and non-vegetarian; 100 are smokers and vegetarian and the remaining 140 are non-smokers and vegetarian. Their chances of getting a particular chest disorder are 35%, 20% and 10% respectively. A person is chosen from the group at random and is found to be suffering from the chest disorder. The probability that the selected person is a smoker and non-vegetarian is:

- (A) $\frac{14}{45}$ (B) $\frac{8}{45}$ (C) $\frac{7}{45}$ (D) $\frac{28}{45}$

Q70 Quadratic Equations & Polynomial Inequalities[Step-by-step solution](#) › [prepwisar.in/questions/KKRIMzxnm](https://www.prepwisar.in/questions/KKRIMzxnm)

Let α and β be the roots of $x^2 - 6x - 2 = 0$. If $a_n = \alpha^n - \beta^n$ for $n \geq 1$, then the value of $\frac{a_{10} - 2a_8}{3a_9}$ is:

- (A) 3 (B) 2 (C) 4 (D) 1

Q71 Sequences & Series[Step-by-step solution](#) › [prepwisar.in/questions/5_2AprPTs](https://www.prepwisar.in/questions/5_2AprPTs)

The minimum value of $f(x) = a^{a^x} + a^{1-a^x}$, where $a, x \in \mathbb{R}$ and $a > 0$, is equal to:

- (A) $a + \frac{1}{a}$ (B) $2a$ (C) $a + 1$ (D) $2\sqrt{a}$

Q72 Indefinite Integration[Step-by-step solution](#) › prepwiser.in/questions/nJIWg1snkb

The integral $\int \frac{e^{3\log_e 2x} + 5e^{2\log_e 2x}}{e^{4\log_e x} + 5e^{3\log_e x} - 7e^{2\log_e x}} dx, x > 0$, is equal to : (where c is a constant of integration)

- (A) $\log_e \sqrt{x^2 + 5x - 7} + c$ (B) $4\log_e |x^2 + 5x - 7| + c$
 (C) $\frac{1}{4}\log_e |x^2 + 5x - 7| + c$ (D) $\log_e |x^2 + 5x - 7| + c$

Q73 Trigonometric Ratios & Identities[Step-by-step solution](#) › prepwiser.in/questions/GMJNi9ycGx

If $0 < x, y < \pi$ and $\cos x + \cos y - \cos(x + y) = \frac{3}{2}$, then $\sin x + \cos y$ is equal to:

- (A) $\frac{1 + \sqrt{3}}{2}$ (B) $\frac{1}{2}$ (C) $\frac{\sqrt{3}}{2}$ (D) $\frac{1 - \sqrt{3}}{2}$

Mathematics Section B · Numerical value

Q74 to Q82

Q74 Three Dimensional Geometry**NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/W0aHvwL3-W

A line 'l' passing through origin is perpendicular to the lines

$$l_1 : \vec{r} = (3 + t)\hat{i} + (-1 + 2t)\hat{j} + (4 + 2t)\hat{k}$$

$$l_2 : \vec{r} = (3 + 2s)\hat{i} + (3 + 2s)\hat{j} + (2 + s)\hat{k}$$

If the co-ordinates of the point in the first octant on 'l₂' at a distance of $\sqrt{17}$ from the point of intersection of 'l' and 'l₁' are (a, b, c) then $18(a + b + c)$ is equal to _____.

Q75 Applications of Derivatives**NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/2_xX3i5nEj

If the curves $x = y^4$ and $xy = k$ cut at right angles, then $(4k)^6$ is equal to _____.

Q76 Binomial Theorem**NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/kfjE1_0Uz3

If the remainder when x is divided by 4 is 3, then the remainder when $(2020 + x)^{2022}$ is divided by 8 is _____.

Q77 Definite Integration**NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/Sw0erNDph9

The value of $\int_{-2}^2 |3x^2 - 3x - 6| dx$ is _____.

Q78 Differential Equations**NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/j-nj94ZAQR

If the curve, $y = y(x)$ represented by the solution of the differential equation $(2xy^2 - y)dx + xdy = 0$, passes through the intersection of the lines, $2x - 3y = 1$ and $3x + 2y = 8$, then $|y(1)|$ is equal to _____.

Q79 Continuity & Differentiability**NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/I3UddbQ3H4

A function f is defined on $[-3, 3]$ as

$$f(x) = \begin{cases} \min\{|x|, 2 - x^2\}, & -2 \leq x \leq 2 \\ [x], & 2 < |x| \leq 3 \end{cases}$$

where $[x]$ denotes the greatest integer $\leq x$. The number of points, where f is not differentiable in $(-3, 3)$ is _____.

If

$$\lim_{x \rightarrow 0} \frac{ax - (e^{4x} - 1)}{ax(e^{4x} - 1)}$$

exists and is equal to b, then the value of $a - 2b$ is _____.

A line is a common tangent to the circle $(x - 3)^2 + y^2 = 9$ and the parabola $y^2 = 4x$. If the two points of contact (a, b) and (c, d) are distinct and lie in the first quadrant, then $2(a + c)$ is equal to _____.

Let $\vec{a} = \hat{i} + \alpha\hat{j} + 3\hat{k}$ and $\vec{b} = 3\hat{i} - \alpha\hat{j} + \hat{k}$. If the area of the parallelogram whose adjacent sides are represented by the vectors $\vec{a}$ and $\vec{b}$ is $8\sqrt{3}$ square units, then $\vec{a} \cdot \vec{b}$ is equal to _____.

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Physics

1. C	2. A	3. D	4. A	5. B	6. D	7. D	8. D
9. A	10. C	11. A	12. B	13. C	14. B	15. A	16. B
17. A	18. C	19. C	20. 1	21. 2	22. 2	23. 10	24. 36
25. 20	26. 10	27. 208	28. 2	29. 180			

Chemistry

30. C	31. D	32. C	33. B	34. D	35. B	36. B	37. A
38. A	39. B	40. D	41. C	42. C	43. D	44. A	45. D
46. 1	47. 52	48. 4	49. 9077	50. 3	51. 181	52. 1	53. 15
54. 6							

Mathematics

55. D	56. A	57. A	58. A	59. D	60. A	61. C	62. B
63. B	64. A	65. C	66. C	67. B	68. D	69. D	70. B
71. D	72. B	73. A	74. 44	75. 4	76. 1	77. 19	78. 1
79. 5	80. 5	81. 9	82. 2				

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